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Handbook for Repairing Nonconventional Roofing Systems

by
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As built-up roofs (BURs) on Army facilities wear out, many are being replaced with nonconventional roofing systems. Problems can arise when a roof mechanic uses a repair procedure appropriate for a BUR to repair a defect in one of the newer nonconventional roofing systems.

This handbook provides illustrated repair procedures for nonconventional roofing, including single-ply elasto-plastics, modified bitumens, and sprayed-in-place polyurethane foam.

Information in this manual applies to all Army installations that have facilities with nonconventional roofing systems needing emergency or permanent repair. Routine maintenance and inspection procedures are not included.

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FOREWORD

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The work was performed by Mr. Carter Doyle and Mr. Wayne Dillner of the University of Illinois, Small Homes Council - Building Research Council for the U.S. Army Construction Engineering Research Laboratory (USA-CERL) Engineering and Materials Division (EM). USA-CERL's Principal Investigator at the beginning of the work was Mr. Myer J. Rosenfield. Mr. Dave Bailey is the current Principal Investigator. Dr. Robert Quattrone is Chief, USA-CERL-EM. The technical editor was Gloria Wienke, USA-CERL Information Management Office.

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HANDBOOK FOR REPAIRING NONCONVENTIONAL ROOFING SYSTEMS

1 INTRODUCTION

Background

As built-up roofs (BURs) on Army facilities wear out, many are being replaced with nonconventional roofing systems. Problems can arise when a roof mechanic uses a repair procedure appropriate for a BUR to repair a defect in one of the newer nonconventional roofing systems. Many times the result is an ineffective and unsightly repair that may cause more damage to the roof than the original defect. Information in this handbook can help to identify the type of roofing system and the appropriate repair procedure.

Purpose and Scope

This manual provides illustrated repair procedures for nonconventional roofing, including single-ply elasto-plastics, modified bitumens, and sprayed-in-place polyurethane foam. A procedure to determine the type of elasto-plastic membrane and, consequently, the appropriate repair procedure is included. Routine maintenance and inspection procedures are not included.

Applicability

Information in this manual applies to all Army installations that have facilities with nonconventional roofing systems needing emergency or permanent repairs. The following document is related to this material but is not required for understanding: *Roofing Materials Guide*, National Roofing Contractors Association, One O'Hare Center, 6253 River Road, Rosemont, IL 60018.

Mode of Technology Transfer

Information in this report is currently being prepared as an Army Technical Manual.

2 EMERGENCY REPAIRS

Timing

Occasionally a nonconventional roofing system will need an emergency repair. The typical situation requires a quick, temporary repair simply to seal the roof until a permanent repair can be made. An emergency repair should be replaced by a permanent repair within 1 week.

Procedure

To complete an emergency repair, use the following steps:

- Use a broom or stiff brush to sweep any debris away from the area to be repaired.
- Dry the area as completely as possible.
- Cut a patch of any available roofing membrane 10 to 12 in. larger in each direction than the damaged area.
- Apply a 4- to 6-in. band of black roofing mastic around the damaged area. It should be applied so all edges of the patch will be embedded in mastic. Take care not to get any mastic on the substrate (insulation or roof deck).
- Embed the patch firmly in the mastic.
- Spread mastic on the edges of the patch.

Long-term exposure to roofing mastic can damage many nonconventional roofing systems. Make sure to remove all traces of the roofing mastic when the permanent repair is made. Normally, all areas to which the roofing mastic was applied must be cut away before making the permanent repair.

3 IDENTIFYING THE ROOFING SYSTEM TYPE

Documentation or Visual Inspection

The first step in repairing a nonconventional roof is to determine the type of roofing system. Ideally, installation documentation can be checked to determine the exact type of roofing system. However, this is not always the case.

Sprayed-in-place polyurethane foam roofs are easy to recognize. Modified bitumen systems are fairly easy to identify by the melted bitumen which oozes out from the seams during application. Modified bitumen membranes may be smooth or they may be coated with metallic sheet or mineral granules. They may closely resemble BUR with mineral-surface cap sheet.

Many of the single-ply elasto-plastic systems (CPE, CSPE, EPDM, Neoprene, PIB, and PVC) look very much alike. Some manufacturers of single-ply membranes emboss their trademark on the membrane. Printed labels may be visible on the membrane. If these identification methods fail, use the procedure described in **The Identification Procedure** below to determine the type of elasto-plastic membrane and, consequently, the appropriate repair procedure. Chapter 4 describes the single-ply systems. This information can be used to confirm the membrane type determined by the identification procedure.

The Identification Procedure

Use the identification procedure described below (and summarized in Figure 1) to determine the membrane type.

- Cut an 8- to 10-in.-square sample from the roof membrane near the defect. Sampling at this location allows you to check the substrate for signs of water damage and repair the whole area with a single patch.
- Carry out the following tests. (The test numbers correspond to the diamond shapes in Figure 1.)
 1. Is membrane rubber-like? Try to stretch the membrane. Does it stretch easily and snap back when released? If reinforced, does it bend easily? If either answer is YES, skip to test 5. If the answer is NO, go to test 2.
 2. Is membrane very stiff and nonflexible? Try to fold the sample. Is the membrane difficult to bend, do cracks appear on the surface, or does the membrane snap when folded? If the answer is YES, the membrane is PVC which has lost the plasticizers. Use the PVC repair method. If the answer is NO, go to test 3.
 3. Is membrane soluble in xylene? Scrub the sample with a stainless steel scouring pad and xylene solvent using a vigorous circular motion (the xylene solvent must be from a tightly sealed container). Does the membrane begin

to dissolve and become tacky? If the answer is YES, the membrane is CSPE (Hypalon*). Use the CSPE repair method. If the answer is NO, go to test 4.

4. Is membrane soluble in THF? Wipe the sample with a cotton rag and Tetrahydrofuran (THF) solvent. Does the membrane begin to dissolve and become tacky? If the answer is YES, the membrane is PVC or CPE. Use either the PVC or CPE repair method. Note that PVC can be repaired with CPE and vice versa. If the answer is NO, the membrane type is unknown. Use any repair method which works and schedule the building for reroofing.
5. Does membrane have a fleece backing? Is the underside of the sample covered with a layer of fleece? If the answer is YES, the membrane is PIB. Use the PIB repair method. If the answer is NO, the membrane is either EPDM or Neoprene. Use the EPDM repair method.

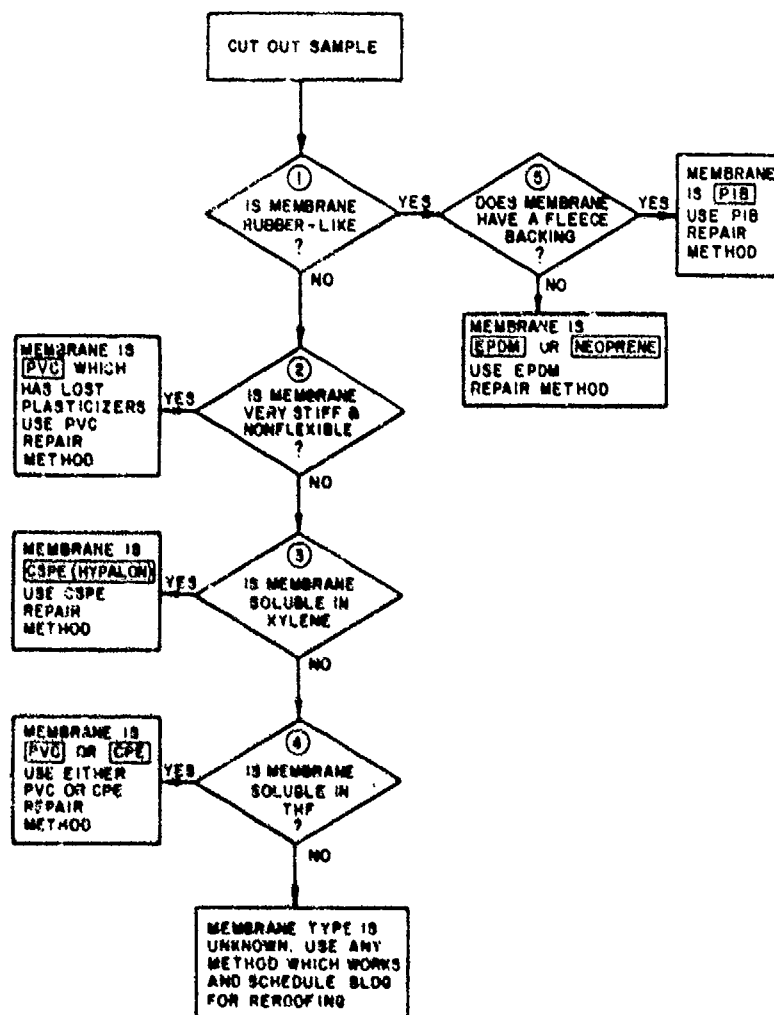


Figure 1. Single-ply membrane identification procedure.

*Hypalon is a registered trademark of E. I. DuPont de Nemours and Company.

4 PERMANENT REPAIRS

Materials and Tools

Repairing nonconventional roofing systems requires some materials and tools that may not be in the typical toolbox. These items should be obtained beforehand and stored together so they are readily available when a repair is needed. A stock of expendable supplies (e.g., solvents and cleaners) should also be kept on hand.

The following items are needed for single-ply elasto-plastic membrane roofing repairs.

- Clean white all-cotton rags (do not use any synthetic materials)
- General purpose spray cleaner
- Household scouring powder
- Stiff natural bristle scrub brush
- Wire brush (stainless steel)
- Metal or plastic pail
- Several stainless steel scouring pads
- Several 3-in. wide (approximately) natural bristle paint brushes
- Sharp scissors
- Blunt screwdriver or other probe to check integrity of seams
- Solvents (xylene, tetrahydrofuran, and toluene)
- Solvent-resistant gloves
- Several small hard-surfaced rollers (metal and rubber-covered metal, 1- to 2-in. wide)
- Seaming adhesives and seaming tapes
- Hot air gun and electric extension cord (100 ft)
- Sealants
- Sandbag (for weighting down patches).

The following items are needed for modified bitumen roofing repairs.

- Portable fire extinguisher
- Propane torch and tank of propane fuel

- Brush or roller for applying primer
- Pointed trowel
- Small, heavy-gage metal plate for heating material
- Utility knife

The following items are needed for sprayed-in-place polyurethane foam roof repairs.

- Serrated long-blade knife (bread knife)
- Flat-nose shovel with sharp edge
- Several 3-in. wide (approximately) natural bristle paint brushes

Product Information

Names of manufacturers, tradenames, and detailed information about the products may be obtained from the *Roofing Materials Guide*, published every February and August by the National Roofing Contractors Association, One O'Hare Centre, 6250 River Road, Rosemont, IL 60018. All splicing and sealing materials should be obtained from manufacturers of the membrane products.

CAUTION: Solvents and adhesives can be toxic. Refer to cautionary statements on containers for proper protective measures, use, and storage.

CPE (Chlorinated Polyethylene)

Product Information:

- **Application Techniques:** fully or partially adhered, mechanically fastened, and loosely laid and ballasted
- **Colors:** white, gray (other colors available)
- **Thicknesses:** 40 to 48 mils
- **Flashing Material:** CPE-coated metal or CPE
- **Reinforcement:** polyester (may have fleece backing)
- **Field Lap Joint Method:** heat or solvent weld

CPE is normally manufactured as an uncured elastomeric thermoplastic roofing membrane which is either calendered or extruded in sheet form. The formulation is inherently flexible and does not require the addition of plasticizers. Polyester reinforcement can be laminated into the membrane. CPE can be installed directly over an existing asphalt or coal tar roof. CPE is strongly resistant to oils and chemicals and has excellent weatherability and ozone resistance. CPE is normally white or light grey for energy efficiency, but other colors are manufactured.

CPE membranes do not vulcanize, or cure, when exposed to the weather. A CPE membrane which has been in place for many years can be repaired by solvent or heat welding without worrying about poor adhesion to "surface-cure" of the existing membrane. Except for preliminary cleaning to remove environmental dirt, patching an existing CPE membrane is the same as seaming a brand new membrane.

Procedures for permanent repair of CPE membrane are as follows:

- Apply general purpose spray cleaner to the area to be repaired (Figure 2).
- Scrub the membrane thoroughly with a stiff-bristled brush to loosen surface contamination. Apply more cleaner if necessary (Figure 3).
- Wipe up the cleaning residue with a clean wet cotton rag. Rinse the rag frequently (Figure 4).
- Dry the area thoroughly with a clean dry cotton rag (Figure 5).
- Cut a patch from a roll of new CPE material, rounding all corners. The patch should be several inches larger in both dimensions than the defect being repaired. Clean the back of the patch using the same procedure used to clean the roof membrane (Figure 6).
- Using a hot air gun, tack a strip along the center of the patch to hold it in place (Figure 7).
- Start at the center of the patch and weld it to the roof using a rubber-faced roller and the hot air gun (Figure 8).

- Continue welding the patch, working from the center to the edges to avoid wrinkling the patch (Figure 9).
- To complete the repair, apply a bead of sealant around the edges of the patch to keep water from wicking into the reinforcing scrim.



Figure 2. Apply spray cleaner to the CPE membrane.



Figure 3. Scrub the CPE membrane.



Figure 4. Wipe the cleaning residual off the CPE membrane.



Figure 5. Dry the CPE membrane after cleaning.



Figure 6. Clean the back of the CPE patch.

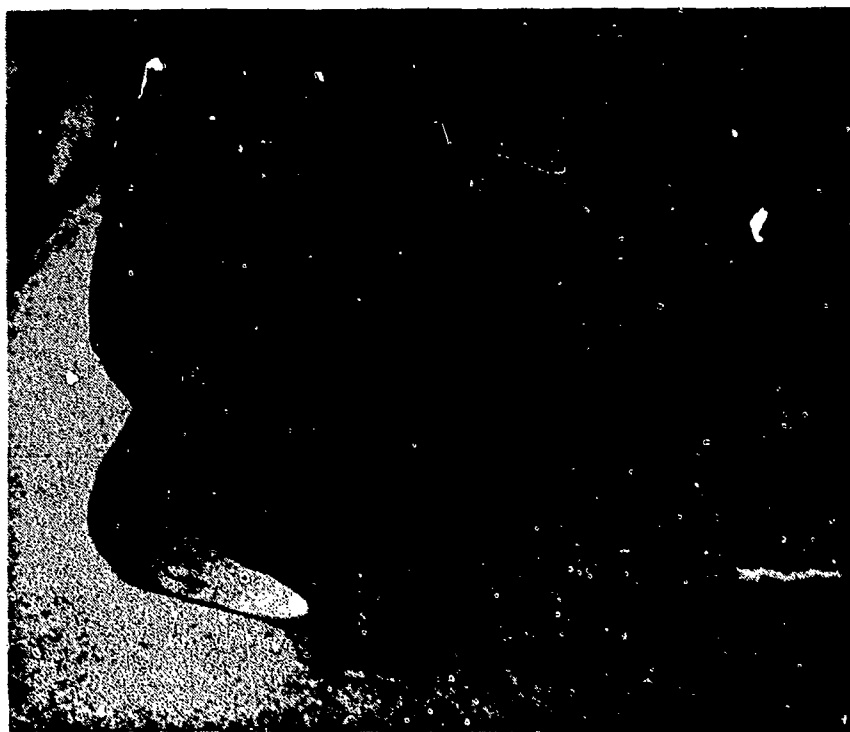


Figure 7. Tack the CPE patch in place.

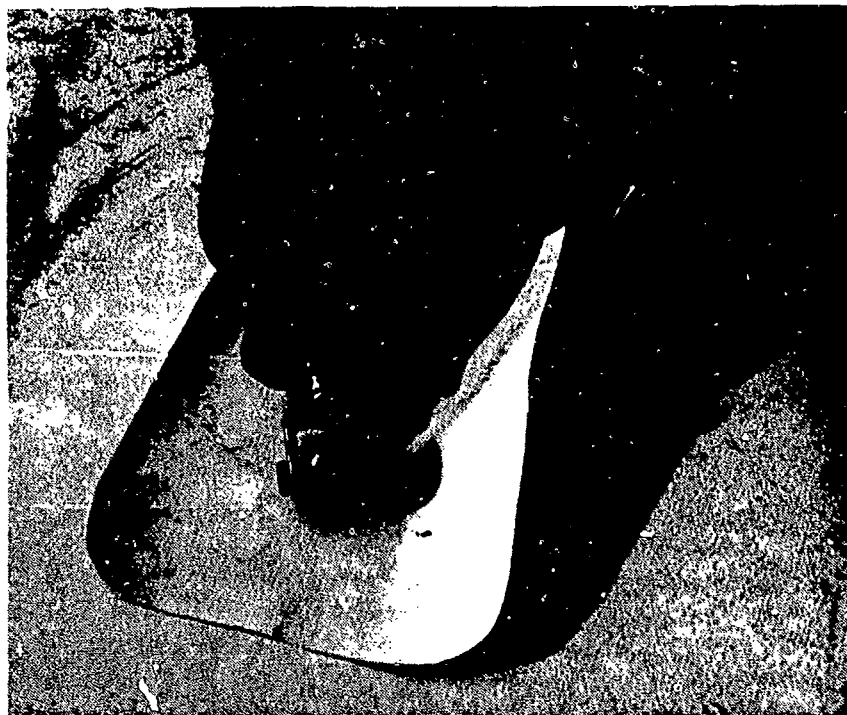


Figure 8. Begin to weld the CPE patch to the roof.



Figure 9. Work from the center to the edges of the CPE patch.

CSPE (Chlorosulfonated Polyethylene)

Product information:

- **Application Techniques:** fully adhered, loosely laid and ballasted, and mechanically fastened
- **Colors:** all colors
- **Thicknesses:** 37 and 90 mils
- **Flashing Material:** CSPE-coated metal, reinforced and nonreinforced membrane material
- **Reinforcement:** polyester (may have fleece backing)
- **Field Lap Joint Method:** heat or solvent weld or welding solution

CSPE, a synthetic rubber, was introduced in 1951 by DuPont under the trade name Hypalon. It is a self-curing nonvulcanized elastomer and is available as a liquid coating or in sheet form for single-ply membrane application. The sheets are usually calendered with a polyester scrim or backed with a fiber felt material. As a result of environmental exposure, the nonvulcanized product cures and cross-linking occurs. Before the membrane cures, the seams are formed by heat or solvent welding. After it has cured, adhesive or heat and solvent are needed to seal seams or make repairs. CSPE is available in many colors and is adaptable to a variety of roof shapes and substrates.

Because cross-linking occurs when the membrane cures, a successful repair depends on proper preparation of the existing roof membrane. The recommended procedure requires that the membrane first be cleaned with xylene. The membrane's surface cure is then removed using a scouring pad and more xylene. The patch is adhered with seaming adhesive. If seaming adhesive is not available, in the alternate procedure, the patch is simply heat-welded to the roof after the surface cure has been removed from the roof membrane.

CAUTION: The alternate (heat-welded) procedure may not be successful if the CSPE membrane has been exposed on the roof for more than 1 year. If the membrane has been exposed for 1 year or more, use the recommended (seaming adhesive) procedure. If it is not possible to obtain the proper seaming adhesive, in the event that the specific manufacturer is not known, the membrane can be cleaned thoroughly with detergent and water and patched using a contact cement which will develop the required bond strength.

Procedures for using seaming adhesive to repair CSPE are as follows. (Not all photographs show use of proper protective measures. Protective devices help minimize health risks.)

- Clean the area to be repaired using a clean cotton rag soaked in xylene. Note: Detergent and water should not be used to clean the membrane, use only xylene (Figure 10).
- If the membrane to be repaired is anything but brand new, its top surface will have cured from exposure to the elements. Remove this cured layer using a stainless steel scouring pad and xylene (Figure 11).

- Dip the scouring pad in xylene and scrub the membrane using firm pressure and a circular motion. The slightly rough surface will become smoother as the surface cure is removed and forms "crumbs." (Figure 12).
- It may be necessary to rewet the scouring pad once or twice before all of the surface cure is removed. A properly prepared surface will be quite tacky. Use a clean cotton rag dampened with xylene to remove all surface cure "crumbs" and any other debris (Figure 13).
- Cut a patch from new CSPE material an inch or two larger than the defect to be covered and round all the corners (this step not shown). Liberally apply xylene to the back of the patch using a clean cotton rag soaked in xylene to activate the patch. If you are working on the roof, use a sheet of cardboard to protect the existing membrane from solvent (Figure 14).
- Note how the xylene has begun to dissolve the black CSPE on the underside of the patch (the rag was originally white) (Figure 15).
- If the repair is being made during cold weather, a hot air gun should be used to warm the surface of the roof before applying the adhesive. Use a paintbrush to apply a liberal coat of seaming adhesive. The seaming adhesive is not contact cement; it is Hypalon dissolved in xylene (Figure 16).
- Lay the patch in place over the defect. The adhesive will allow the patch to be repositioned, if necessary (Figure 17).
- Roll the patch vigorously with a small hard-surfaced roller to set it and to remove trapped air bubbles (Figure 18).
- Thoroughly coat the edges of the patch with seaming adhesive or CSPE-compatible seam caulk. This step is required if the patch has a reinforcing scrim, and optional (but still recommended) if the patch is unreinforced (fig 19).

Note: the patch does not achieve full strength until all of the xylene has evaporated from the adhesive. The patch is weathertight within minutes, but at least 24 hours should pass before the edges of the patch are probed for unadhered areas.

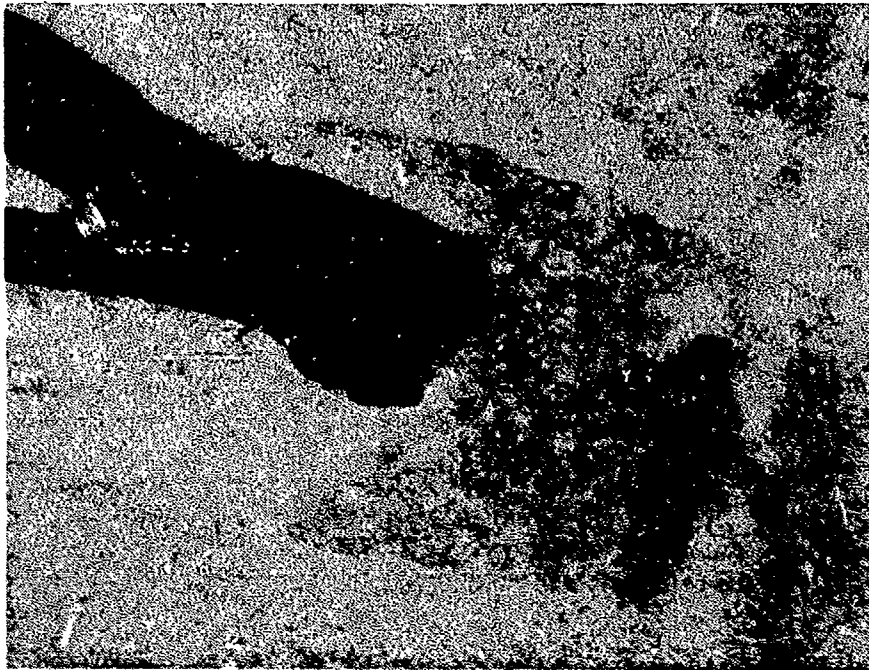


Figure 10. Clean the CSPE membrane with xylene.

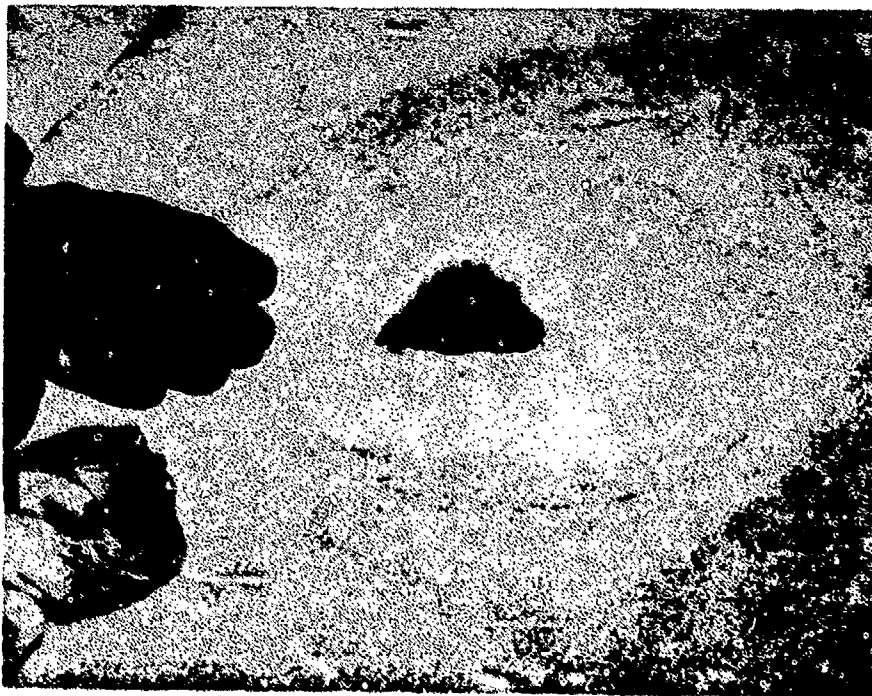


Figure 11. Remove the cured CSPE surface.



Figure 12. "Crumbs" form as the cured CSPE surface is removed.



Figure 13. Remove the "crumbs" from the tacky CSPE surface.

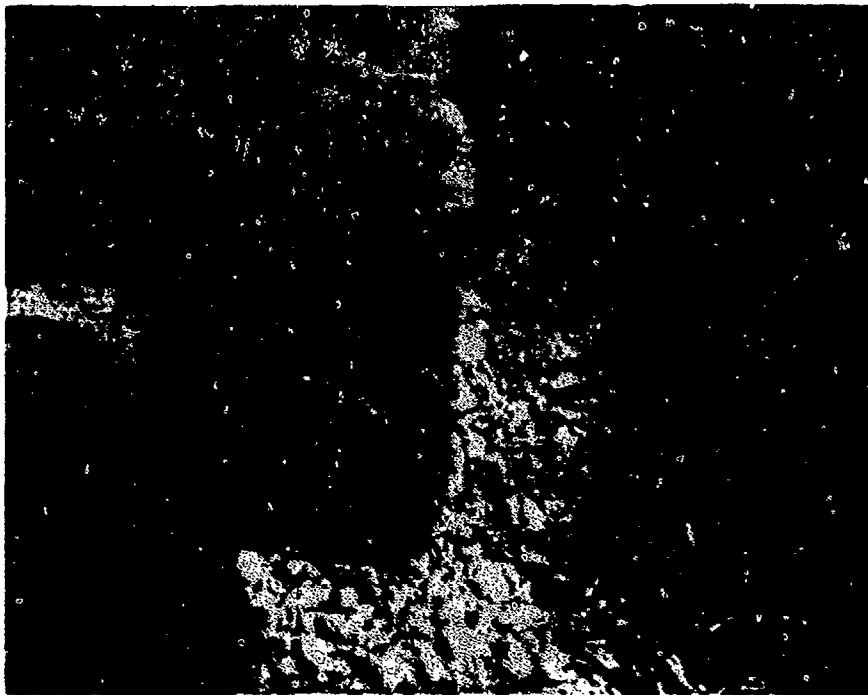


Figure 14. Apply xylene to the back of the CSPE patch.



Figure 15. Xylene begins to dissolve the back of the CSPE patch.



Figure 16. Apply seaming adhesive to the CSPE membrane.



Figure 17. Position the CSPE patch.

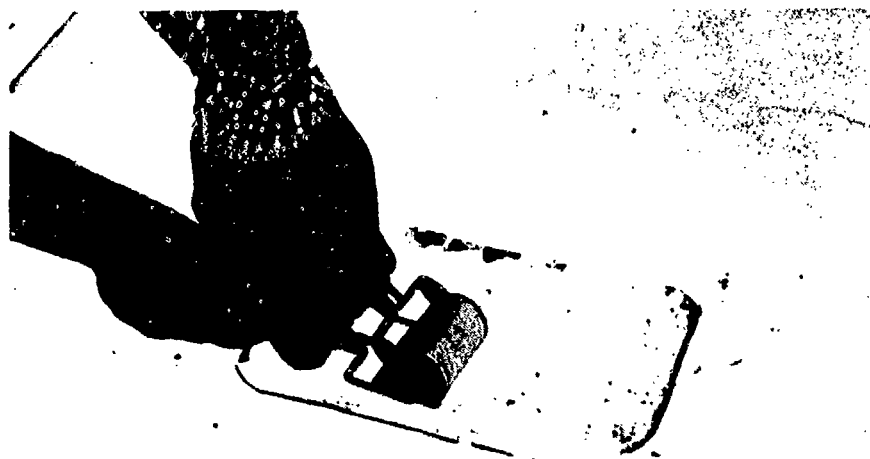


Figure 18. Roll the CSPE patch.



Figure 19. Apply seaming adhesive to the edges of the CSPE patch.

Procedures for using a hot air gun to repair CSPE are as follows. This procedure is not recommended if the roof is more than 1 year old. (Not all photographs show use of proper protective measures. Protective devices help minimize health risks.)

- Clean the membrane using a clean cotton rag soaked in xylene. Change the rag if necessary to thoroughly clean the surface (Figure 20).
- Scrub the membrane with a stainless steel scouring pad soaked with xylene to remove the top layer of material which has cured from exposure to the elements. Use firm pressure and a liberal amount of xylene. The surface will begin to feel smoother and "crumbs" will form if the proper scrubbing pressure is used (Figure 21).
- Use a clean cotton rag dampened with xylene to remove the "crumbs" and other debris (Figure 22).
- Cut a patch from new CSPE material several inches larger than the defect and round all the corners. Lightly scrub the back of the patch with a stainless steel scouring pad soaked with xylene. If the patch is cut from a roll of new material, there will be very little, if any, surface cure to be removed. Protect the existing roof membrane from solvent with a heavy piece of cardboard or similar material (Figure 23).
- Wipe the back of the patch with a clean cotton rag dampened with xylene to remove any debris (Figure 24).
- Lay the patch in place on the roof and use a hot air gun and a rubber-covered steel roller to weld the patch to the roof. Start at the center of the patch and gradually work outward, keeping firm pressure on the roller (Figure 25).
- Work carefully to avoid wrinkling the patch. The hot air gun should be moved quickly enough to avoid scorching the membrane, yet slow enough to assure a proper weld is made (Figure 26).
- The exposed reinforcement on the edges of the patch must be sealed so water cannot wick into the patch. If a CSPE-compatible seam caulk is not available, melt the edge of the patch with the hot air gun and use the roller to spread the melted material over the exposed reinforcement (Figure 27).



Figure 20. Use xylene to clean the CSPE membrane.



Figure 21. Use a scouring pad to remove the cured CSPE surface.



Figure 22. Wipe "crumbs" from the CSPE surface.



Figure 23. Scrub the back of the CSPE patch.

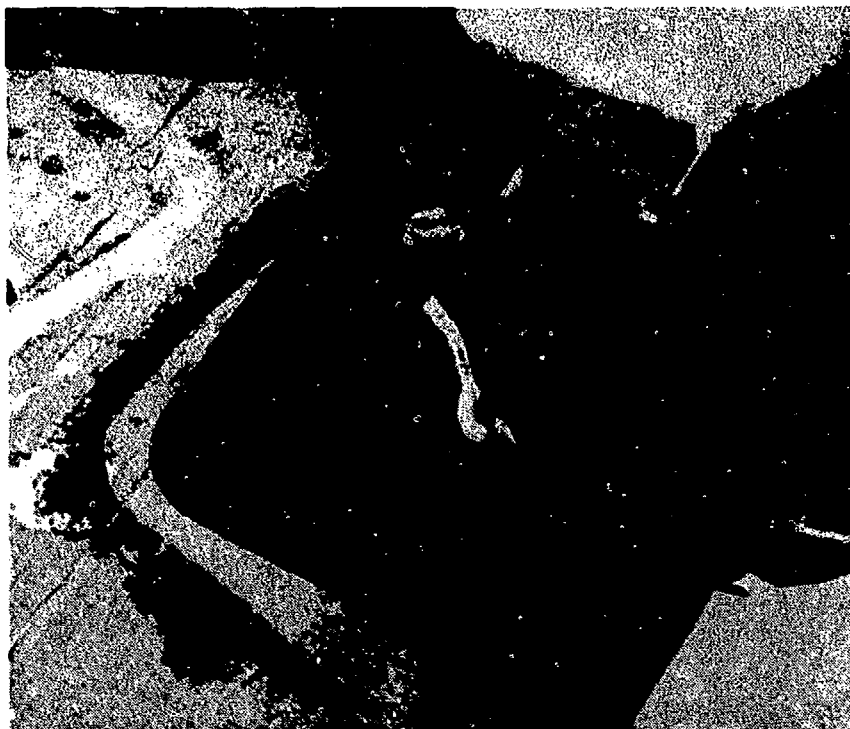


Figure 24. Wipe the back of the CSPE patch.



Figure 25. Weld the center of the CSPE patch.



Figure 26. Roll from the center to the edges of the CSPE patch.



Figure 27. Use melted patch material to seal the patch.

EPDM (Ethylene Propylene Diene Monomer)

Product information:

- **Application Techniques:** fully or partially adhered, loosely laid and ballasted, and mechanically fastened
- **Colors:** black (normally), white
- **Thicknesses:** 39 to 70 mils
- **Flashing Material:** uncured neoprene, uncured EPDM
- **Reinforcement:** none (usually)
- **Field Lap Joint Method:** contact adhesive or tape (seam caulking may be required)

EPDM is an elastomeric material that has been used as a roofing material in the United States since the early 1960's. Although it is possible to formulate an EPDM membrane which is nonvulcanized, roofing membranes are generally vulcanized. EPDM is quite resistant to ozone, ultraviolet, weathering, and abrasion, and has good low temperature flexibility. EPDM largely retains its properties of resilience, tensile strength, elongation, and hardness. When exposed to contaminants as listed above, the membrane will distort and often swell. On the other hand, EPDM has excellent resistance to acids, alkalis, animal and vegetable oils, and oxygenated solvents like alcohols, esters, and ketones. Sometimes a top coating of Hypalon (CSPE) and sand is used to provide fire resistance and a white or light-colored surface.

Repairs to vulcanized elastomers like EPDM can only be made by using contact adhesives or double-stick splicing tape. Both of these repair methods are illustrated on the following pages.

Procedures for permanent repair of EPDM using contact adhesive are as follows. (Not all photographs show use of proper protective measures. Protective devices help minimize health risks.)

- Clean the existing membrane using a scrub brush or a plastic scouring pad with a household scouring powder and water (Figure 28). It may be necessary to rinse the membrane and repeat the cleaning process several times to ensure that the membrane is clean.
- Rinse the surface with clean water to remove the detergent residue. It is important that the membrane be wiped clean (Figure 29).
- Let the membrane air-dry before continuing (Figure 30).
- After the membrane is completely dry, clean it again with splice cleaner (Figure 31). A properly cleaned membrane should be solid black.
- Cut a patch from new EPDM, making sure the corners are rounded and the patch is several inches larger than the defect being repaired. Clean the back of the patch with splice cleaner (Figure 32). Although the patch is cut from new EPDM material, it is often covered with talc and other residue which must be cleaned off to achieve a proper bond.
- After the splice cleaner on the patch has completely dried, apply splicing cement evenly to the patch using a roller or brush (Figure 33). It is important that the splicing cement be spread evenly. If the cement is not applied evenly, the thicker areas will not dry as fast as the thinner areas and the patch might not bond completely.
- Apply splicing cement evenly to the existing roof membrane (Figure 34).
- Let the patch and the membrane dry until tacky (Figure 35).
- When both surfaces are tacky, lift the patch and prepare to place it (Figure 36).
- Carefully align the patch over the area where the splicing cement has been applied to the roof membrane, but **do not put the patch down** (Figure 37).
- Place one end of the patch on the roof while holding up the other end of the patch (Figure 38).
- Begin working the patch down by hand while continuing to hold the opposite end up (Figure 39). This process will help prevent wrinkling or trapping air under the patch.
- Smooth the patch down with hand pressure to ensure that the patch is adhered to the existing membrane (Figure 40). Roll the entire patch with a metal roller.
- Clean the edge of the patch and the adjacent membrane surfaces with splice cleaner (Figure 41). After the splice cleaner has dried, apply a bead of lap sealant at the seam edge to complete the repair.

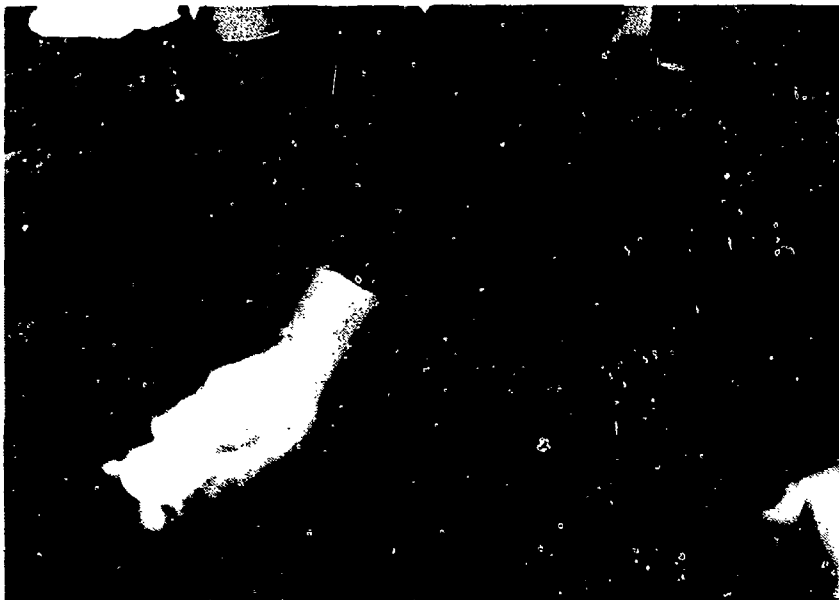


Figure 28. Clean the EPDM membrane.



Figure 29. Rinse and wipe the EPDM membrane.

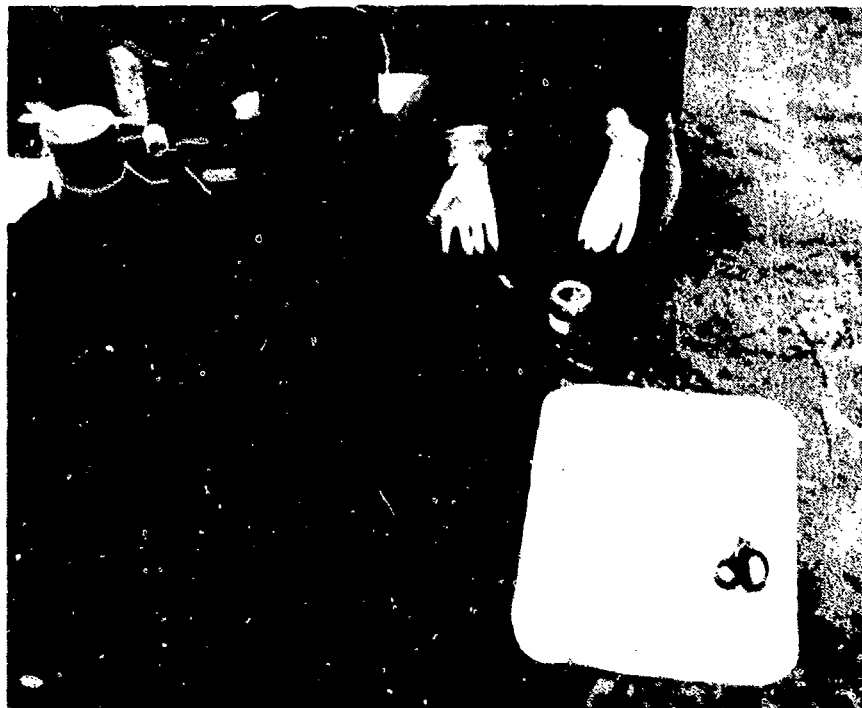


Figure 30. Allow the EPDM membrane to air-dry.



Figure 31. Clean the EPDM membrane with splice cleaner.

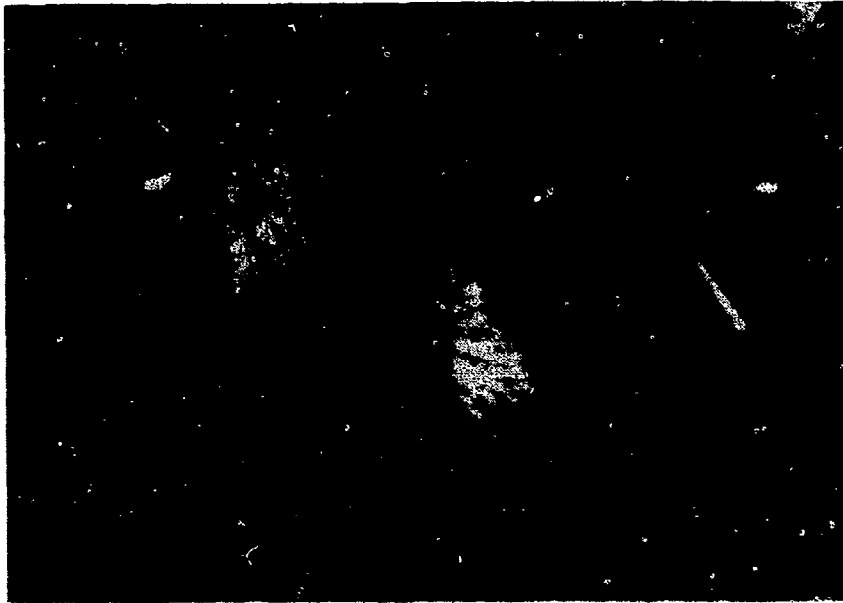


Figure 32. Clean the back of the EPDM patch with splice cleaner.

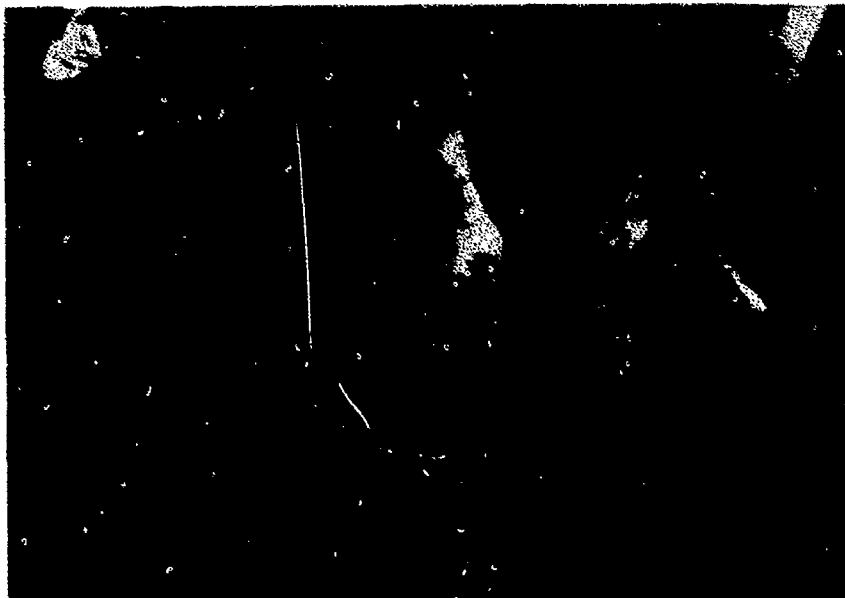


Figure 33. Apply splicing cement to the EPDM patch.



Figure 34. Apply splicing cement to the EPDM roof membrane.

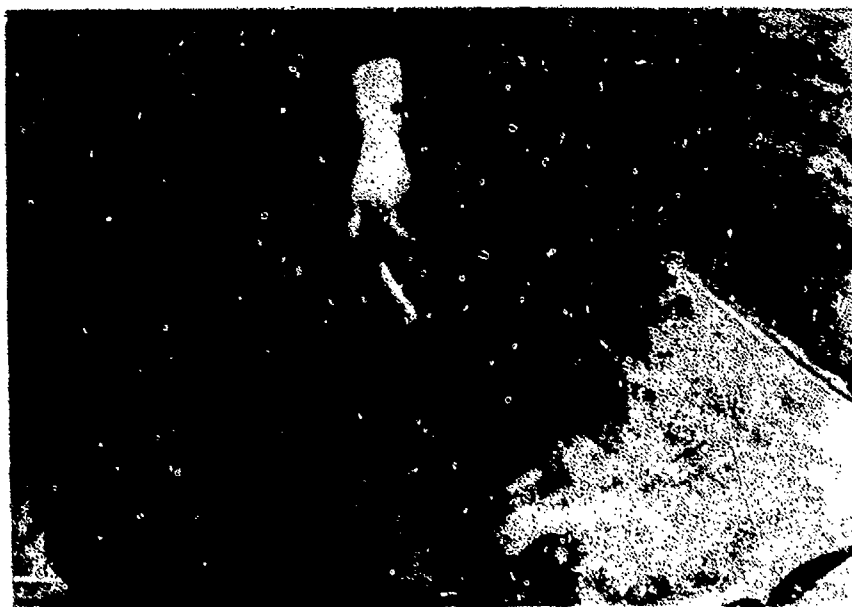


Figure 35. Allow the patch and membrane to dry until tacky.

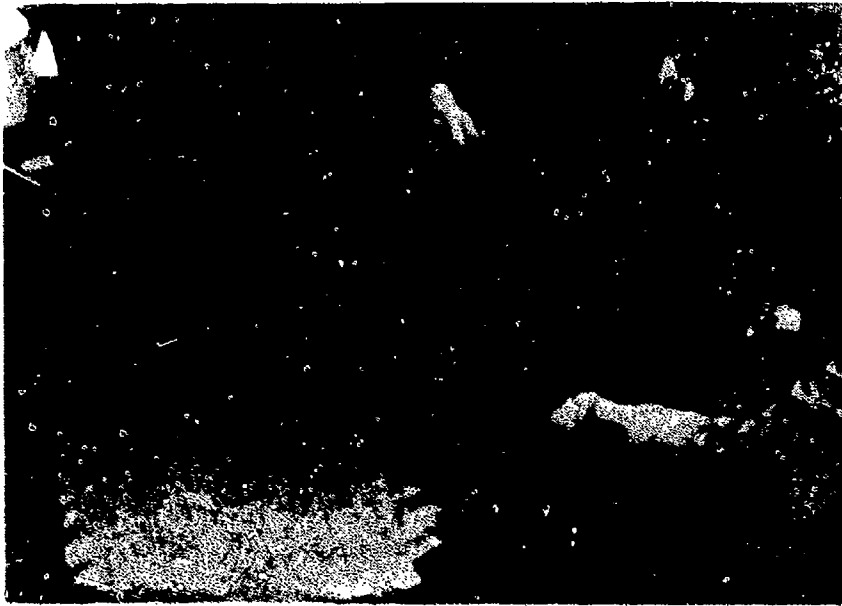


Figure 36. Prepare to place the EPDM patch.



Figure 37. Center the EPDM patch over the damaged membrane.



Figure 38. Place one end of the EPDM patch on the membrane.



Figure 39. Work the EPDM patch down.



Figure 40. Smooth the EPDM patch.

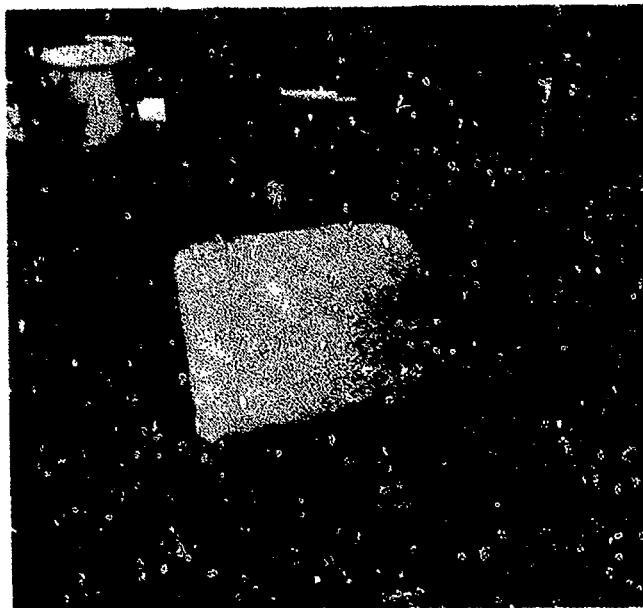


Figure 41. Clean the edge of the EPDM patch and adjacent membrane.

Procedures for permanent repair of EPDM using double-stick seam tape are as follows.

- Wet the area needing repair plus at least 6 in. beyond that area on all sides. Scrub the entire area using a plastic scouring pad and household scouring powder (Figure 42).
- Rinse with clean water (Figure 43).
- Dry the area thoroughly with clean cotton rags (Figure 44). When the area is dry, wipe the surface of the membrane with a dry fingertip to see if any residue remains. If residue comes off on the fingertip, repeat the cleaning process until the fingertip shows that the membrane is clean.
- Cut a piece of plain EPDM large enough to extend 3 in. on each side beyond the area to be repaired. Round all corners on the patch. Clean one side of the patch using the same procedure used to clean the existing membrane. Even if the patch is cut from new material, cleaning is necessary to remove talc and other residue left during manufacturing.
- Apply strips of double-stick seaming tape about 1/2 in. longer than the edges of the patch (Figure 45). The photograph shows strips of tape applied to opposite edges of the cleaned side of the patch. The tape hangs over the edges of the patch.
- Fold back the release paper on the first two strips of tape and apply the remaining strips to the other two edges of the patch (Figure 46). Once again, the tape should be about 1/2 in. longer than the patch and positioned so that it hangs over the edge.
- Apply seaming tape diagonally across the center of the patch (Figure 47). Use hand pressure to be sure all pieces of seaming tape are well adhered.
- With all release paper still attached, position the patch on the roof over the area to be repaired. Fold back one edge of the patch and remove the release paper from that edge (Figure 48). Carefully attach that edge to the roof, rolling it in so air bubbles are not trapped. Fold back the rest of the patch and remove the rest of the release paper. Carefully roll the patch back down onto the roof, working from the adhered edge towards the opposite edge to avoid trapping air bubbles.
- Apply firm pressure to the entire patch with a small steel roller (Figure 49). Complete the repair by applying a bead of lap sealant around the patch.



Figure 42. Scrub the damaged area with scouring powder.

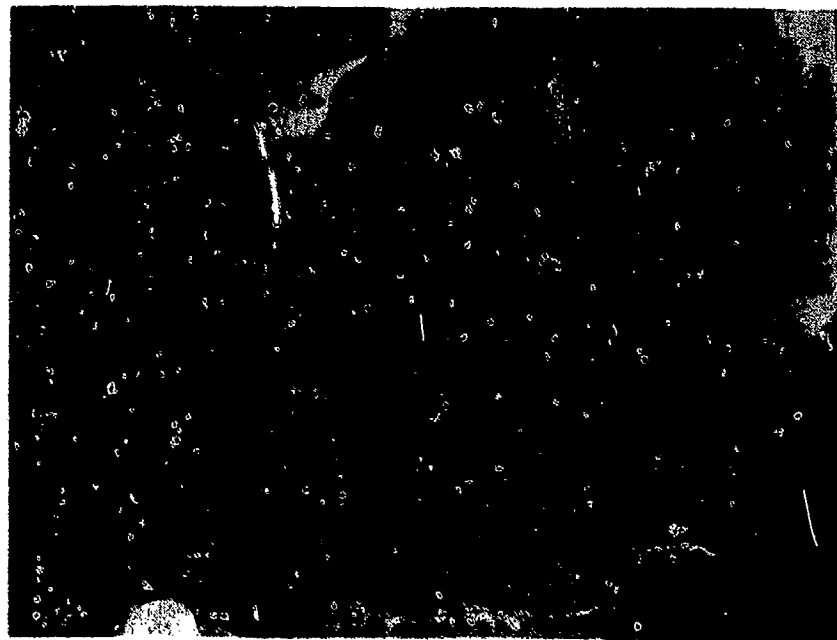


Figure 43. Rinse the cleaned area.



Figure 44. Thoroughly dry the cleaned area.

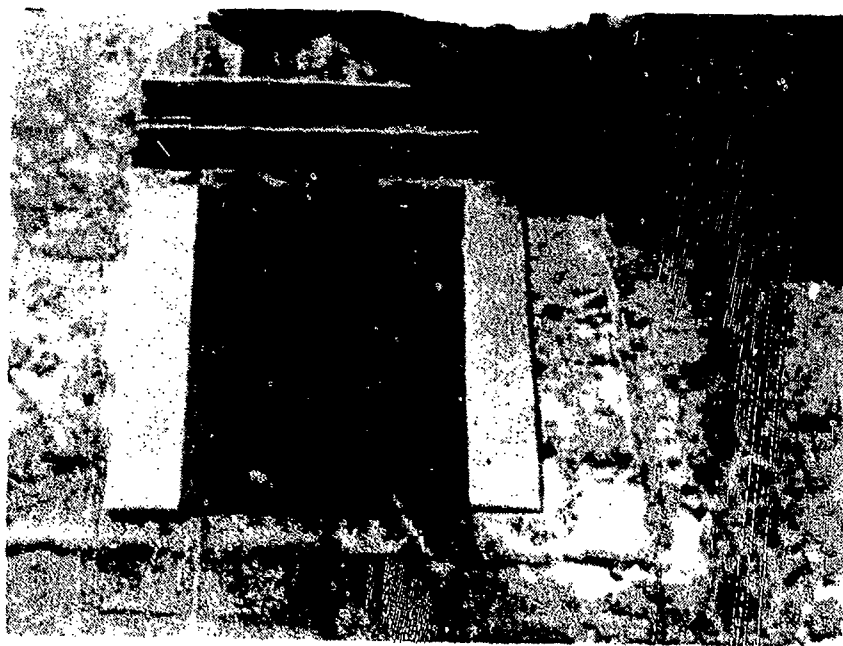


Figure 45. Apply seaming tape to parallel edges of the EPDM patch.

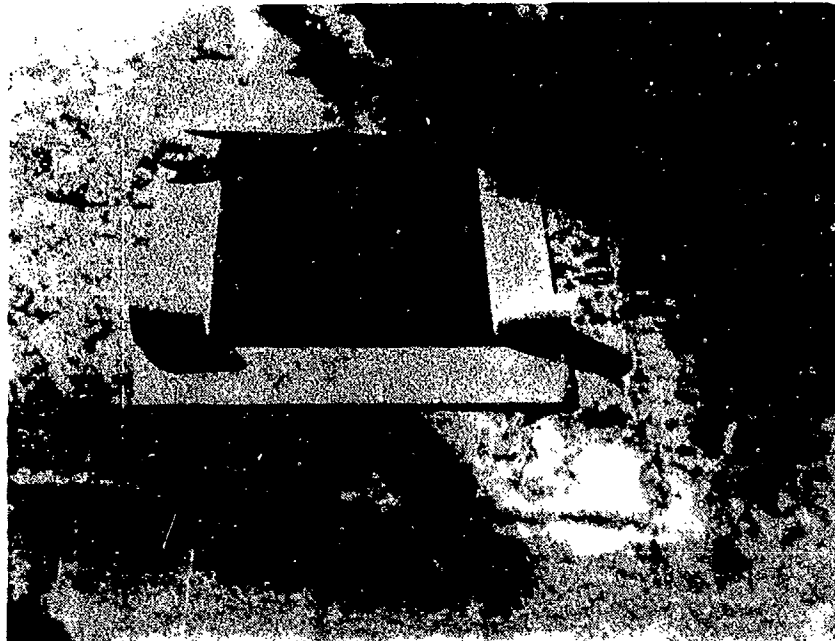


Figure 46. Apply seaming tape to the other two edges of the EPDM patch.

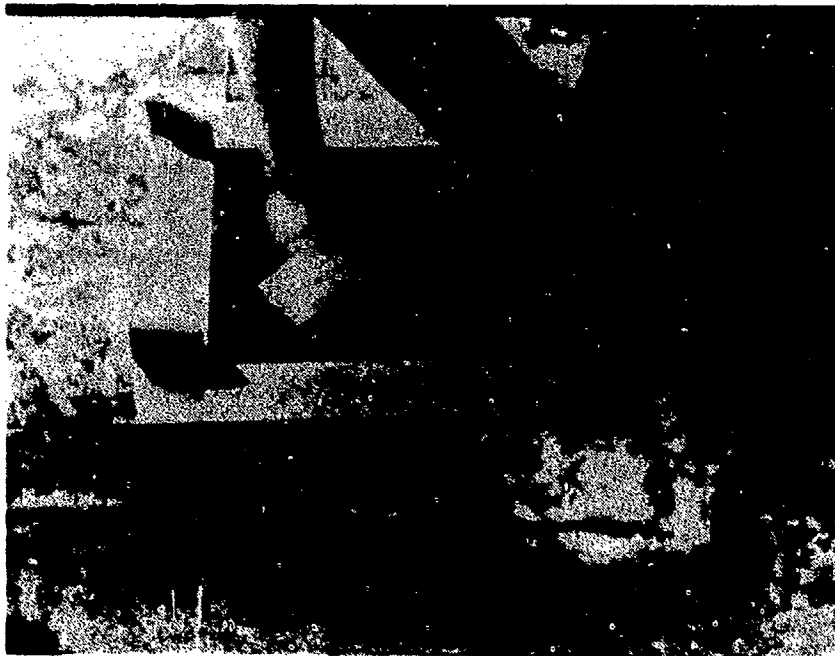


Figure 47. Use hand pressure to apply a piece of tape to the center of the EPDM patch.



Figure 48. Attach the EPDM patch to the roof membrane.



Figure 49. Roll the EPDM patch.

NEOPRENE (Chloroprene Rubber)

Product information:

- **Application Techniques:** fully adhered, loosely laid and ballasted, and mechanically fastened
- **Colors:** black, grey
- **Thicknesses:** 55 to 60 mils
- **Flashing Material:** uncured neoprene
- **Reinforcement:** none
- **Field Lap Joint Method:** contact adhesive

Neoprene was the first synthetic rubber manufactured, and has been used as a roofing membrane material since 1957. Roofing membrane neoprene is manufactured as a cured (vulcanized) elastomer. Neoprene intended to be used as flashing is not vulcanized during manufacture, but will partially vulcanize upon exposure to weather. Neoprene exhibits excellent resistance to weathering, heat, oils, solvents, and abrasion. A coating of liquid CSPE (Hypalon) is sometimes applied to give the roof a uniform color.

The repair procedure for a neoprene roofing membrane is quite similar to the initial installation procedure. The only difference is that the weathered membrane must be cleaned before repairing. Contact adhesives, rather than solvent or hot air welding, are used to join cured neoprene to itself. The repair technique is the same as that for EPDM. Refer to the photographs and descriptions for EPDM beginning on p 34.

PIB (Polyisobutylene)

Product information:

- **Application Techniques:** fully or partially adhered, loosely laid and ballasted, and mechanically fastened
- **Colors:** black, white
- **Thicknesses:** 100 to 120 mils
- **Flashing Material:** self-adhering PIB tape and unbacked PIB
- **Reinforcement:** fleece backing or polyester reinforced
- **Field Lap Joint Method:** self-adhering PIB tape or self-sealing

PIB is an elastomeric compound made of isobutylene and other polymers. It was first used in Europe in the early 1960's and has been available as a roofing membrane in the United States since the mid-1970's. The 60-mil PIB membrane is usually laminated to a 40-mil fleece backing with an unbacked sealing edge for side laps. The end laps are sealed with PIB tape.

Any one of four repair techniques can be used on PIB membranes, depending on the materials available and the size of the defect to be repaired. To repair small defects, use 3-in. wide self-stick PIB tape. For repairing large defects, 12-in. wide tape with two self-stick edges is available. For even larger defects, a piece of PIB membrane (the edges of which are sealed to the roof with 3-in. wide self-stick tape) can be used. A solvent-welded PIB patch can be used to cover any size of defect. Repairs using the 3-in. and 12-in. wide tapes and solvent welding are illustrated on the following pages.

Procedures for permanent repair of PIB using 3-in. wide self-stick tape are as follows. (Not all photographs show use of proper protective measures. Protective devices help minimize health risks.)

- Clean the PIB with abrasive cleanser and water to remove surface dirt. Once the surface dirt has been removed, wipe the PIB membrane with a rag soaked with toluene solvent (Figure 50).
- Wipe the membrane with toluene again (Figure 51).
- Cut a piece of PIB self-stick repair tape long enough to extend well beyond the ends of the defect. Round the corners of the tape. Remove the backing paper from the patch and lay one end on the membrane. Work the patch down carefully with a small steel roller, starting at one end and working towards the other to avoid trapping air bubbles under the patch (Figure 52).
- After the patch is thoroughly rolled out, check around its perimeter to be sure it is bonded to the roof membrane (Figure 53).
- If portions are not bonded, use a clean rag or paint brush to reapply solvent between the two surfaces (Figure 54).
- Use the steel roller to apply pressure and bond the two surfaces together (Figure 55).

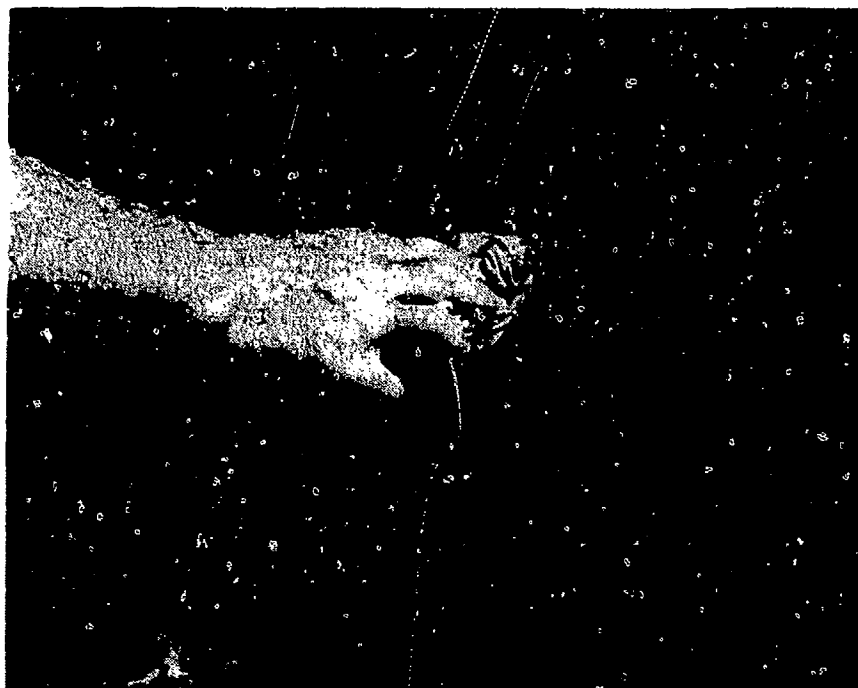


Figure 50. Wipe the PIB membrane with toluene after cleaning.



Figure 51. Wipe the PIB membrane the second time with toluene.



Figure 52. Roll the PIB repair tape.



Figure 53. Check the PIB patch for bonding.



Figure 54. Reapply solvent to unbonded patch.



Figure 55. Roll the PIB patch.

Procedures for permanent repair of PIB using 12-in. wide repair tape are as follows. (Not all photographs show use of proper protective measures. Protective devices help minimize health risks.)

- Cut a strip of the 12-in. wide PIB tape an inch or two longer than the defect. Use household scouring powder and water to clean surface dirt from the defect area. Let the area dry, and use toluene solvent to clean the area where the sides of the patch will adhere (Figure 56).
- Remove the backing paper from one edge of the patch (Figure 57).
- Carefully place this edge on the cleaned roof membrane, working it down from one end to the other to avoid wrinkles and trapped air bubbles (Figure 58).
- Roll the edge with a small steel roller to bond the patch to the existing membrane (Figure 59). Repeat the same procedure on the opposite side of the patch.
- After the two parallel sides of the patch are sealed to the existing membrane, the two ends of the patch must be sealed. Cut a piece of 3-in. wide PIB repair tape long enough to extend about 3 in. past the edges of the patch (Figure 60). Round the corners of the repair tape.
- Clean the end of the patch and the existing membrane thoroughly with toluene solvent, extending well beyond the area to be covered by the repair tape (Figure 61).
- Apply a bead of lap sealant near the end of the adhered sides of the 12-in. wide patch so that when the 3-in. wide tape is applied, the inside seam created by one patch lapping over the other will be sealed (Figure 62).
- Remove the backing paper from the repair tape and place one end down carefully over the end of the patch (Figure 63).
- Work the tape down, smoothing it out from one end to the other to avoid trapping air (Figure 64).
- Roll the patch thoroughly with a small steel roller. Repeat this same procedure at the other end of the patch to complete the repair (Figure 65).



Figure 56. Clean the damaged PIB membrane with toluene.



Figure 57. Remove the backing paper from the PIB patch.



Figure 58. Place one edge of the patch on the PIB membrane.



Figure 59. Roll the edge of the PIB patch.



Figure 60. Cut repair tape to seal the ends of the patch.



Figure 61. Clean the PIB membrane and end of the patch.



Figure 62. Apply a bead of lap sealant.



Figure 63. Place the repair tape on the end of the patch.



Figure 64. Press the repair tape down.

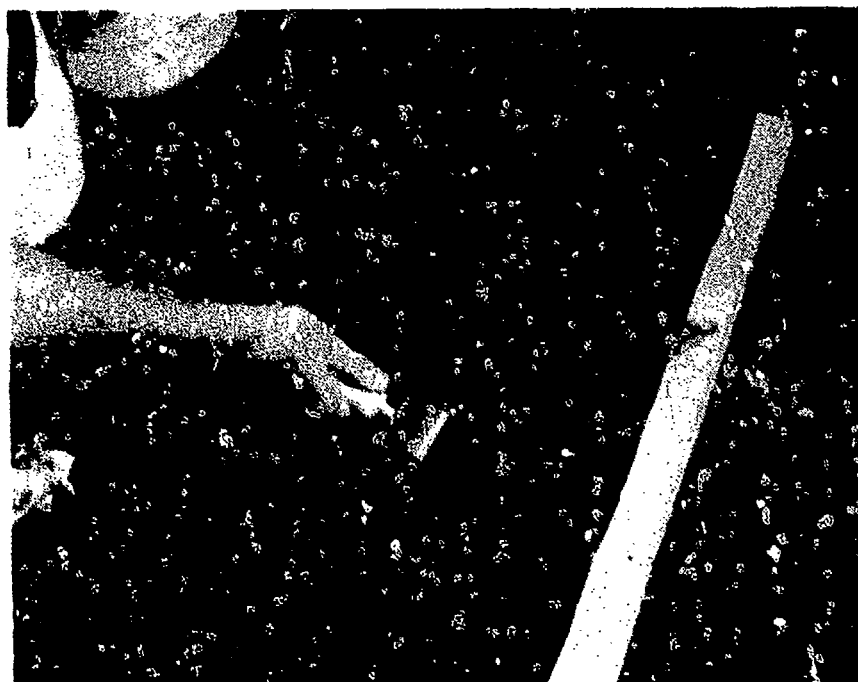


Figure 65. Roll the PIB patch and tape.

Procedures for permanent repair of PIB using solvent welding are as follows. (Not all photographs show use of proper protective measures. Protective devices help minimize health risks.)

- Thoroughly clean the surface to be repaired with a stiff-bristled brush and general purpose spray cleaner (Figure 66).
- Wipe up the cleaning residue with a wet rag (Figure 67). Rinse the rag frequently.
- Dry the surface with a clean dry rag (Figure 68). Make sure the surface is completely dry before continuing.
- Using a paint brush, apply a liberal coat of welding solvent to the cleaned roof membrane (Figure 69).
- Using a circular brushing motion, work the solvent into the surface of the membrane (Figure 70).
- Cut a patch from new PIB material several inches larger than the defect being repaired. Round the corners. Apply a liberal coat of welding solvent to the back of the patch (Figure 71). Note: if the back of the patch is dirty, it should be cleaned using the same procedure used on the roof membrane.
- Work the solvent into the patch using a circular motion (Figure 72).
- Lay the patch in place on the roof membrane (Figure 73).
- Roll the patch in place using a steel roller (Figure 74). Use firm pressure to make sure the patch is well adhered.

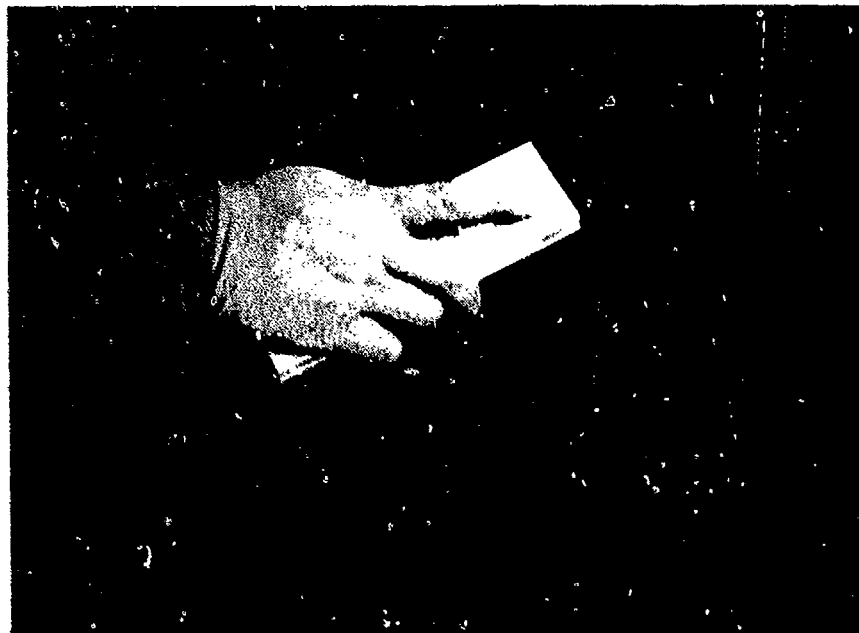


Figure 66. Scrub the PIB membrane.



Figure 67. Wipe the cleaner off the PIB membrane.



Figure 68. Dry the PIB membrane.



Figure 69. Apply solvent to the PIB membrane.



Figure 70. Work the solvent into the PIB membrane.



Figure 71. Apply welding solvent to the PIB patch.



Figure 72. Work the solvent into the PIB patch.



Figure 73. Lay the PIB patch in place.

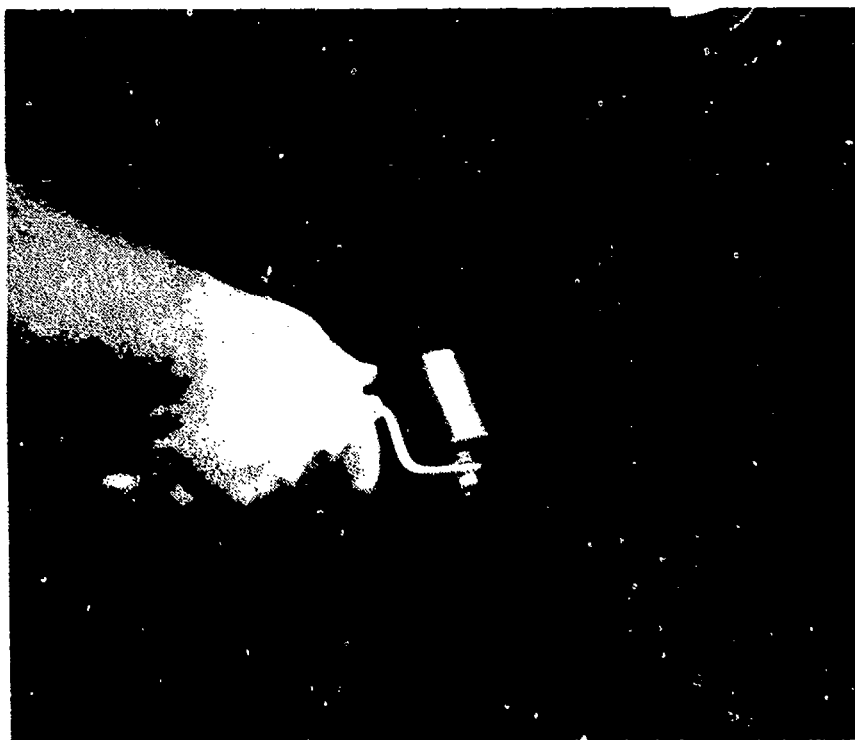


Figure 74. Roll the solvent-welded PIB patch.

PVC (Polyvinyl Chloride)

This category includes thermoplastic alloys, thermoplastic elastomers, and other materials with similar descriptions such as copolymers and interpolymers.

Product information:

- **Application Techniques:** fully or partially adhered, loosely laid and ballasted, and mechanically fastened
- **Colors:** white, other assorted colors
- **Thicknesses:** 33 to 60 mils
- **Flashing Material:** PVC or PVC-coated metal
- **Reinforcement:** polyester or fiberglass (woven or non-woven)
- **Field Lap Joint Method:** solvent or heat weld (seam caulking may be required)

PVC membranes are produced from thermoplastic polyvinyl chloride modified with stabilizers and plasticizers. PVC membranes may be produced by calendaring, extruding, or spread coating. Thermoplastic materials can be modified by applying heat. They soften when heated and harden when cooled. Temperatures outside the range of normal conditions are required to soften the material. Seams are formed by heat or solvent welding. PVC materials are resistant to bacterial growth, industrial chemical atmospheres, root penetration, and extreme weather conditions. They may or may not be resistant to fungi. PVC membranes have excellent fire resistance and seaming capabilities. They will melt when exposed to flame but will not burn nor support combustion.

PVC repair techniques are basically the same as for a new application of a PVC fully adhered system except that the existing roof membrane must be thoroughly cleaned before the process begins. The patch is cut from PVC membrane and is heat or solvent welded to the existing roof. The edge of the patch must be protected with lap sealant just as any field joint would be in a new application, unless the manufacturer specifically states otherwise.

Procedures for permanent repair of PVC using solvent and heat welding. (Not all photographs show use of proper protective measures. Protective devices help minimize health risks.)

- Clean the area to be repaired using clean rags and a general purpose spray cleaner (Figure 75). Methyl-ethyl-ketone (MEK) may also be used.
- Use a clean wet rag to rinse away all cleaning residue (Figure 76). The membrane should be close to its original color after cleaning.
- Cut a PVC patch with rounded corners large enough to extend several inches beyond the damaged area (Figure 77).

- Lay the patch over the damaged area and apply tetrahydrofuran (THF) welding solvent to both surfaces simultaneously using a paint brush (Figure 78). The solvent should be stored in a tightly sealed bottle or it will absorb moisture and become useless. Work the brush filled with solvent all around under the patch to ensure adhesion.
- Weight the patch with a sandbag to promote adhesion (Figure 79).
- Remove the sandbag after about 5 minutes and check the patch carefully for lack of adhesion (Figure 80).
- Use a hot air gun to weld any unadhered areas (Figure 81). The hot air gun should be kept moving to avoid scorching or excessively melting the membrane.
- Use a small metal roller after the hot air gun to weld the patch to the roof (Figure 82).
- Apply lap sealant around the edges of the patch to complete the repair (Figure 83).



Figure 75. Clean the PVC membrane.

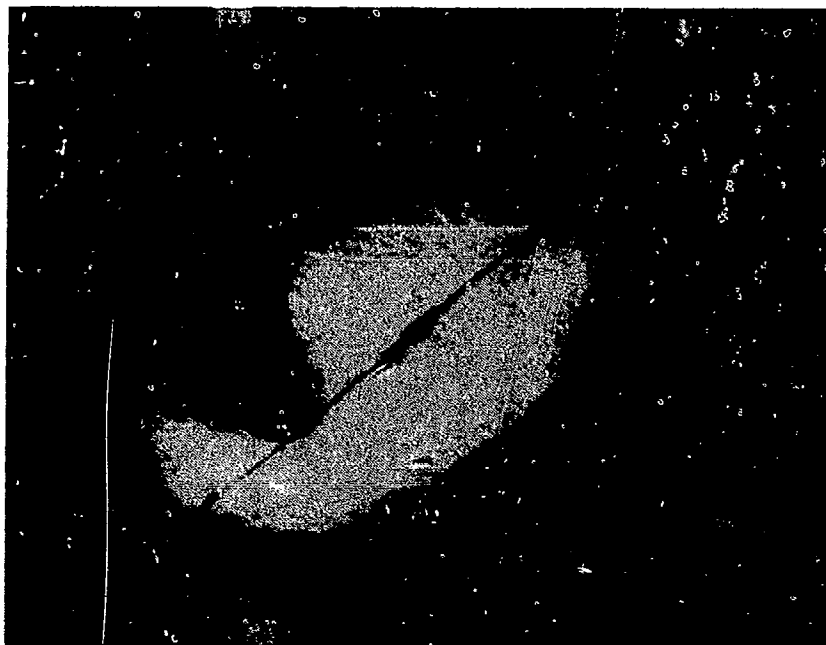


Figure 76. Rinse the PVC membrane.



Figure 77. Cut a PVC patch.

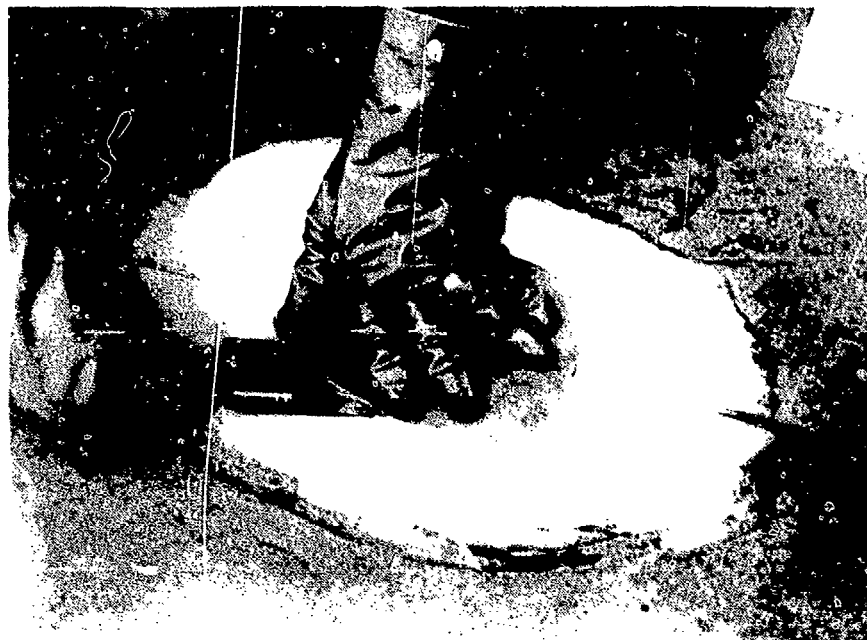


Figure 78. Apply tetrahydrofuran between the PVC membrane and the patch.



Figure 79. Weight the PVC patch.

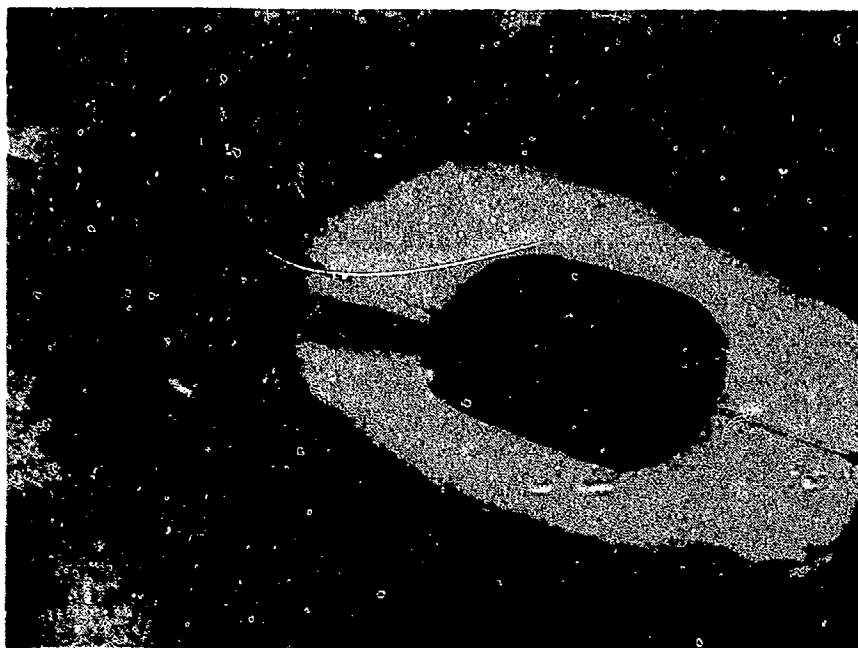


Figure 80. Check the PVC patch for adhesion.

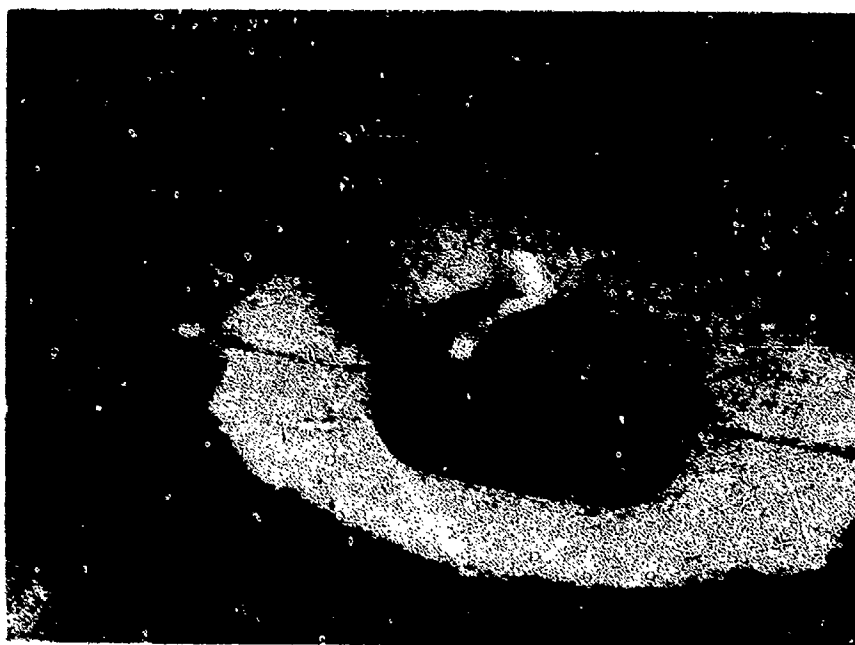


Figure 81. Use a hot air gun to weld unadhered areas.

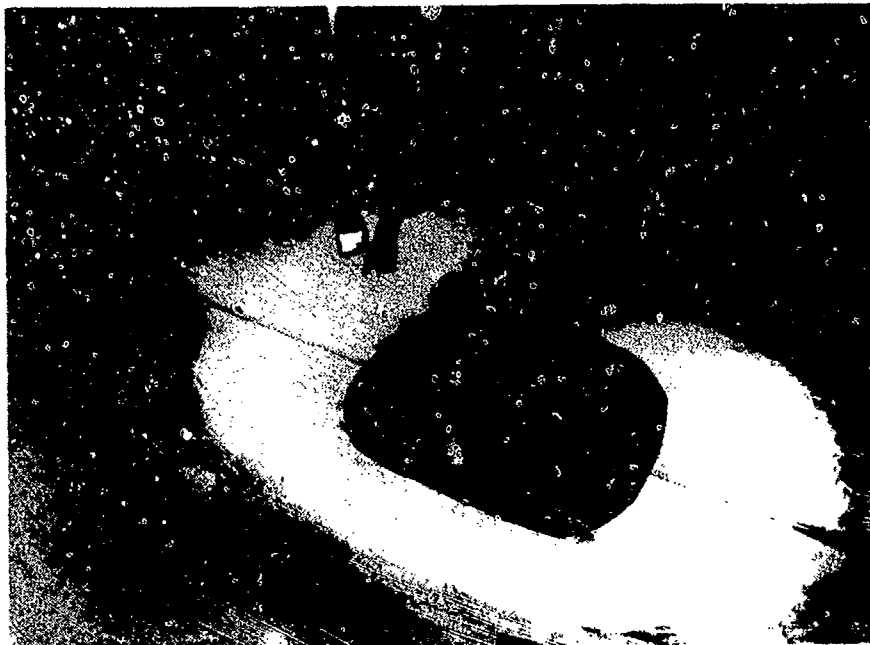


Figure 82. Roll the unadhered areas after heating.



Figure 83. Apply lap sealant.

Procedures for permanent repair of PVC using only heat welding are as follows. (Not all photographs show use of proper protective measures. Protective devices help minimize health risks.)

- Clean the area to be repaired using clean white all-cotton rags and a general purpose spray cleaner (Figure 84). Methyl-ethyl-ketone (MEK) may also be used. Repeat if necessary.
- Use a clean wet rag to wipe away all residue from the defect area (Figure 85).
- Cut a PVC patch with rounded corners large enough to extend several inches beyond the damaged area (Figure 86).
- Lay the patch over the damaged area and use a hot air gun to weld the patch to the roof (Figure 87). Start at the center and work towards the outside edge to avoid trapping air under the patch. Keep the gun moving to avoid scorching or excessively melting the membrane.
- Follow behind the air gun with a small metal roller to weld the patch to the roof (Figure 88). Use firm pressure on the roller.
- Check for unadhered areas around the edges of the patch (Figure 89). If any are found, use the hot air gun and roller to adhere the area.
- Apply lap sealant around the edges of the patch to complete the repair (Figure 90).



Figure 84. Clean the damaged PVC membrane.



Figure 85. Wipe residue from the damaged PVC membrane.



Figure 86. Cut and round the corners of the PVC patch.

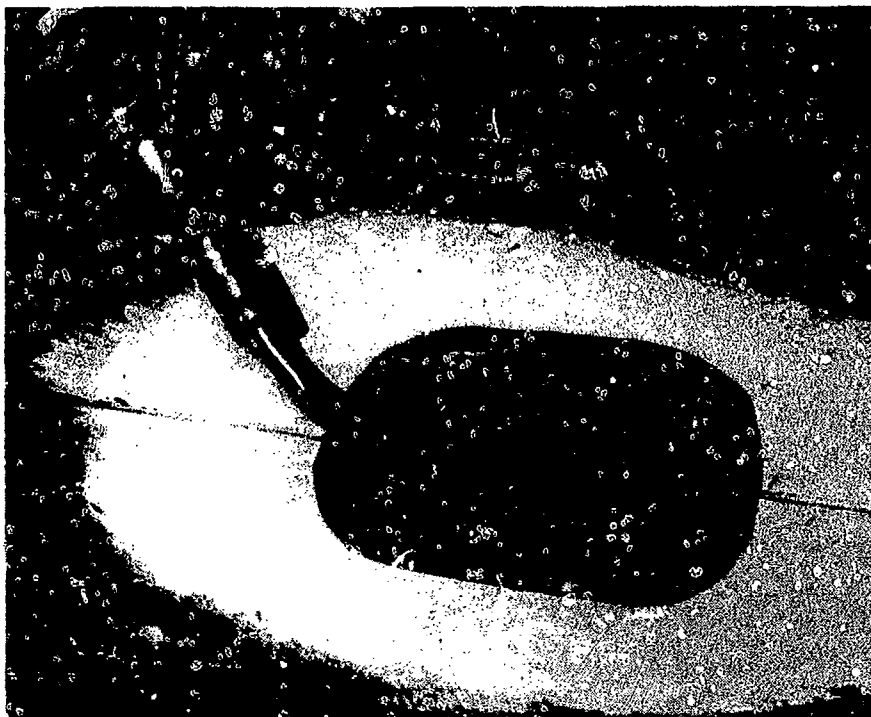


Figure 87. Use a hot air gun to weld the PVC patch.

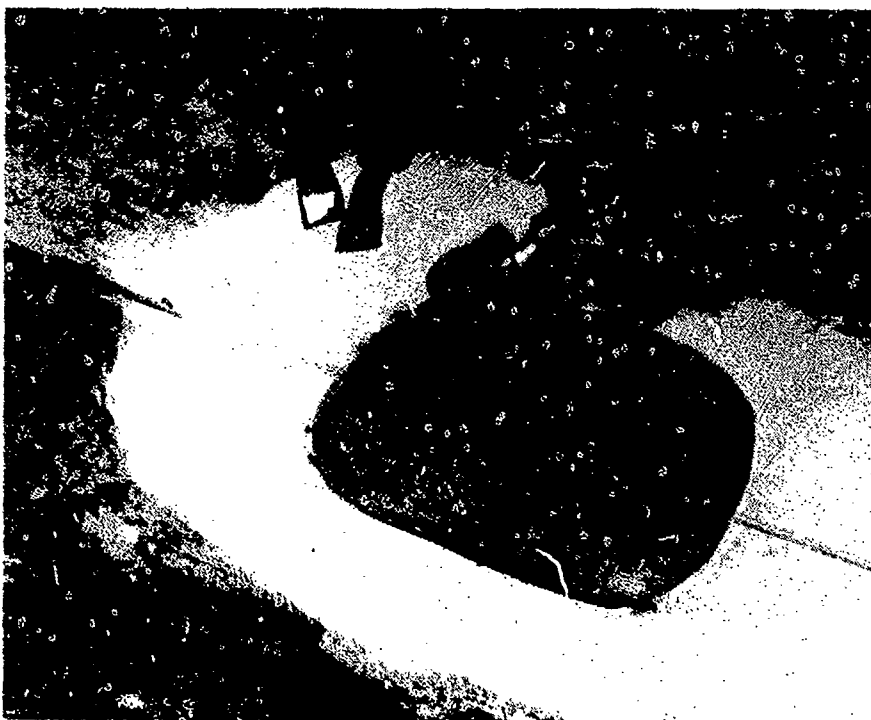


Figure 88. Roll the PVC patch after heating.



Figure 89. Check for unadhered areas around the PVC patch.

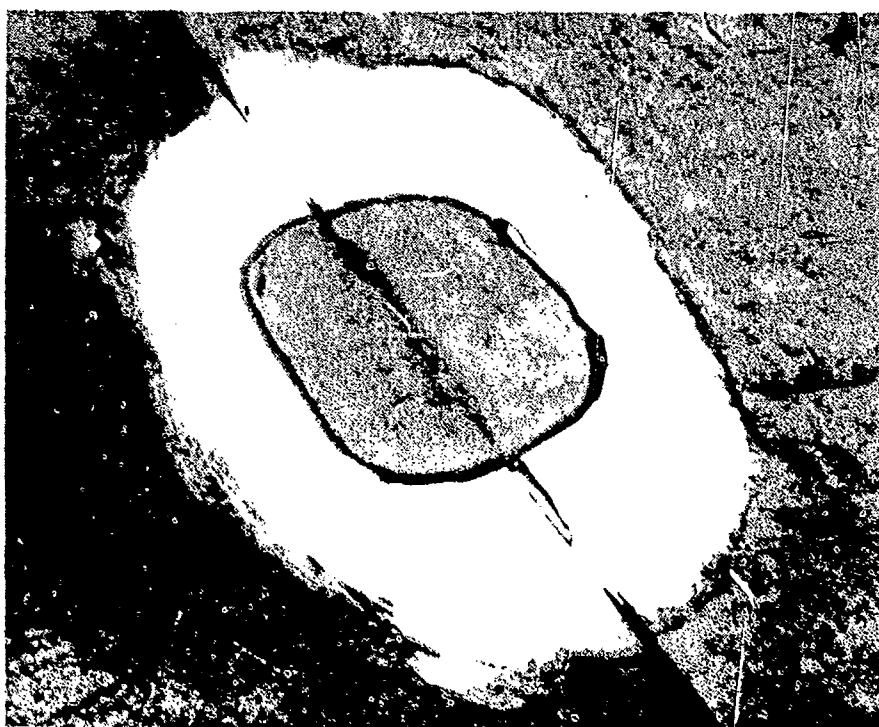


Figure 90. The completed PVC repair.

Modified Bitumen

Product Information:

- **Application Techniques:** fully or partially adhered, loosely laid and ballasted
- **Colors:** black, white, and various others
- **Thicknesses:** 70 to 200 mils
- **Top Surface:** granular, metal foil, smooth
- **Flashing Material:** modified bitumen membrane material
- **Reinforcement:** polyester, fiberglass (woven or nonwoven)
- **Field Lap Joint Method:** torch, hot mopped, cold adhesive, self-adhering

Modified bitumen roofing membranes are composite sheets consisting of bitumen and modifying compounds, such as styrene-butadiene-styrene (SBS) or atactic polypropylene (APP). The membranes are reinforced with plastic films, polyester mats, glass fibers, felts, or fabrics which may be laminated to one surface or embedded within the modified bitumen. The membranes may be further protected with liquid coatings, metallic laminates, ceramic granules, or mineral aggregate to enhance ultra-violet (UV) and fire resistance. Modified bitumen membranes may be installed loosely laid and ballasted, partially or fully adhered with cold adhesives, hot asphalt, or by heating the membrane with a torch. Some modified bitumen roofing systems are self-adhering with pressure.

The repair techniques for modified bitumen roofing are basically the same as when the membrane is first installed. For example, the self-adhering roof system can be repaired with a self-adhering patch. The method illustrated here is the fully adhered, torch-down repair procedure. All the repair methods require cleaning off dirt and debris and priming the existing roof.

Procedures for permanent repair of modified bitumen using the torch-down method are as follows. Note that local fire regulations may not permit the use of open flames on the roof, or may not permit the direct application of flame to the roof surface. Under any conditions, if the torch-down method is used, a fully-charged fire extinguisher must be kept close at hand.

- Cut a patch from a new roll of modified bitumen large enough to extend 3 to 4 in. beyond the damaged area (Figure 91).
- The area round the repair should be completely dry and free from dirt and debris. Prime the area around the defect by heating the existing roof membrane with the torch flame (Figure 92). If this method is not permitted, apply a thin coat of asphalt primer and allow to dry completely of all solvent before proceeding.
- Put patch down-side up on a small, heavy-gage metal plate. Apply heat to the underside until the bitumen begins to flow. Use the trowel to flip the patch over the area to be repaired.

- Press the patch in place with the trowel. Apply heat to the trowel as it is worked around the edge of the patch to get a good bond between the patch edge and the roof. Some melted bitumen should ooze out along the edges to seal the patch. (Figure 93).
- Use the torch and trowel to seal all edges of the patch with bitumen (Figure 94).
- If not enough bitumen has oozed out to properly seal the edges, extra bitumen can be obtained by torching the back of a scrap piece of membrane and scraping off the melted bitumen (Figure 95).
- Use a trowel to apply the extra bitumen to seal the edge of the patch (Figure 96). The completed patch should resemble Figure 97.



Figure 91. The modified bitumen patch.



Figure 92. Prime the area around the defect.



Figure 93. Press melted bitumen out along the edges of the patch.



Figure 94. Seal the edges of the patch.



Figure 95. Scrape extra bitumen off a membrane scrap.



Figure 96. Apply the extra bitumen.



Figure 97. The completed modified bitumen patch.

Sprayed-In-Place Polyurethane Foam

Sprayed-in-place polyurethane foam roofs have been used successfully for about 20 years. This roofing system is possible because of a chemical reaction which occurs when two components are mixed, creating a rigid, monolithic, insulating layer of foam on the roof deck. The foam is then covered with a liquid coat of silicone, acrylic, or urethane material, although combinations of urethane and Hypalon are often used. Frequently, mineral granules are sprinkled over the final coat before it cures to provide abrasion resistance for the surface. The protective coating is vital to the proper performance of the system. Polyurethane foam degrades quickly when exposed to ultraviolet (UV) radiation and must be coated within a maximum of 72 hr after installation. However, Corps of Engineers Guide Specification CEGS 07540, *Fluid Applied Elastomeric Roofing*, requires same-day coating. While polyurethane foam is water resistant, it cannot be considered waterproof, thus the liquid coating is also necessary as a waterproof barrier over the foam.

Sprayed-in-place polyurethane foam roofs are, as the name implies, manufactured in place on the roof deck. Properly maintained, application equipment is capable of supplying the raw foam mixed in the correct proportions and at the proper pressure and temperature. However, the skill and technique of the installer and the weather conditions when the foam is applied must constantly be controlled and/or monitored. Both ambient temperature and deck temperature at time of installation have an effect on the final product. Wind speed is an important factor also. Ideally, the foam should be applied on a calm day. Winds of up to 12 miles per hour (mph) can be tolerated during application with no special precautions. If temporary windscreens are installed, winds of 12 to 25 mph can be tolerated. Foam should not be applied if winds exceed 25 mph.

Repairing a sprayed-in-place polyurethane foam roof is a fairly straightforward process. As with any roofing repair, proper preparation is important for a lasting repair. Insignificant damage such as breaks in the coating can be repaired by cutting around the break with a sharp knife to form a groove, and filling the groove with silicone sealant which is tooled flush with the surface. For severe damage, the damaged foam must be removed down to the roof deck. A piece of polyurethane board insulation of the proper thickness can be used to fill the hole. In this case, it is convenient if the sides of the hole and the edges of the board are vertical. A second possible repair method is to fill the hole with liquid polyurethane foam from a foam repair kit. If liquid foam is used, the sides of the hole should be sloped away at a 45-degree angle. In either case, at least two coats of coating are applied over the patch (plus a layer of mineral granules if present on the original roof). The coating used over the patch should be the same as the original roof coating if possible. Incompatible coatings may not adhere to the original roof coating. If the surface contains granules, these should be brushed away as completely as possible before new coating is applied.

Procedures for permanent repair of sprayed-in-place polyurethane foam using polyurethane board insulation are as follows. (Note: all photographs in this section courtesy of the U.S. Navy.)

- Remove the damaged material using a flat-nosed shovel. Using a sharp knife or the shovel, make the sides of the hole vertical. A square or rectangular hole will make the rest of the procedure easier (Figure 98).
- Carefully remove as much of the old foam as possible down to the vapor retarder or the deck.

- Prime the bottom of the hole (the vapor retarder or deck) with an asphalt primer. Do not apply primer to the exposed edges of the roof foam.
- Cut a piece of polyurethane board to fit snugly in the hole. The plug should be at least the same thickness as the existing foam. If thicker, it can be sanded down to conform to the surrounding foam.
- Apply a liberal amount of silicone sealant to the vapor retarder or deck (Figure 99) and fit the plug into the hole.
- Seal the edges of the plug with silicone sealant (Figure 100).
- Apply at least three coats of silicone or urethane over the patch, allowing drying time between coats. Cover the repaired area with mineral granules (if desired) before the final coat dries (Figure 101). Acrylic (water based) coatings should not be used with board-stock repairs.



Figure 98. Remove the damaged material.

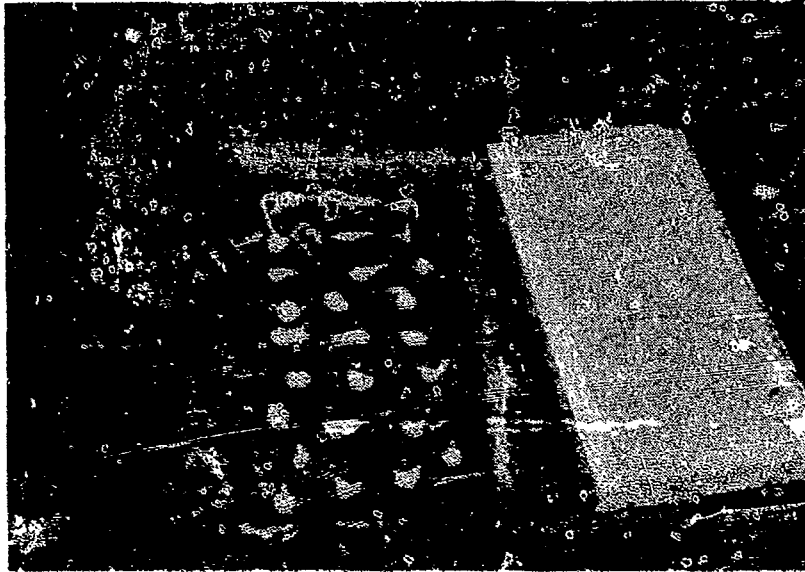


Figure 99. Place silicone sealant in the hole.

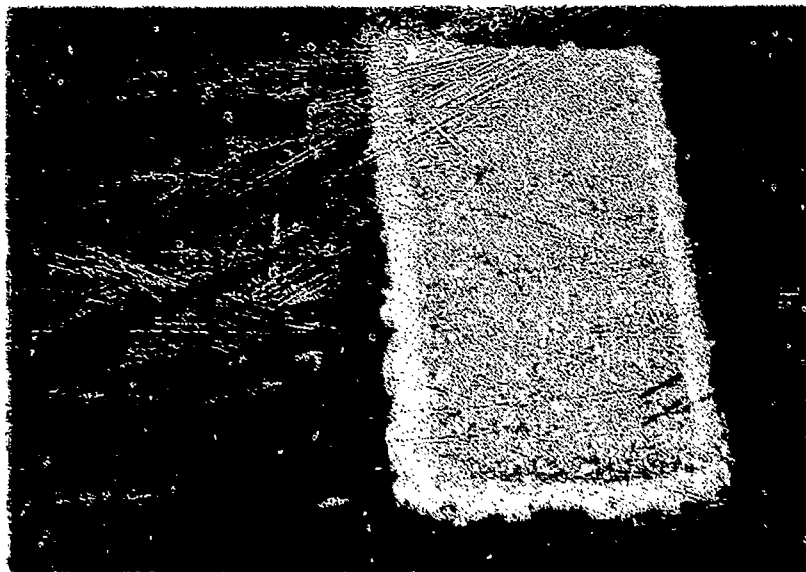


Figure 100. Seal the edges of the plug with silicone sealant.



Figure 101. Cover the repaired area with mineral granules.

Procedures for permanent repair of sprayed-in-place polyurethane foam using a liquid foam repair kit are as follows. (Note: all photographs in this section courtesy of the U.S. Navy.)

- Remove the damaged material using a flat-nosed shovel. Using a sharp knife or the shovel, bevel the sides of the hole back at approximately a 45-degree angle (Figure 102). Carefully remove as much of the old foam as possible down to the vapor retarder or the deck. The exact shape of the hole is not critical in this case, but a regular shape will make things easier.
- Prime the bottom of the hole and the exposed edges of the roof foam with an epoxy or polyolefin primer. New foam adheres best to this type. The heat of the reaction may cause asphalt primer to melt and lose adhesion.
- Obtain a piece of 1/2-in. or 3/4-in. plywood large enough to cover the hole. Cover one side of the plywood with a polyethylene sheet.
- Obtain a foam repair kit (or kits) and mix the materials according to the directions. Fill the hole half full with repair foam and lay the plywood over the top, polyethylene side down. Weight the plywood with concrete blocks.
- When the foam has fully cured a minimum of one half-hour, remove the plywood. If the foam has risen higher than the surrounding surface, it can be trimmed back with a sharp knife (Figure 103) or sanded. If the hole is not completely filled, one or more additional applications may be necessary.
- Use a disc sander to make the cured foam flush with the roof surface (Figure 104).
- It is also possible to pour the foam components into the hole and allow to rise freely. The top surface, which will probably be irregular, is then cut flush with the roof surface and sanded as in steps for Figures 103 and 104.
- Coat the patch with at least three applications of silicone, acrylic, or urethane, allowing drying time between coats. Cover the repaired area with mineral granules (if desired) before the final coat dries.



Figure 102. Remove the damaged material and bevel the sides of the hole.



Figure 103. Trim the expanded foam.



Figure 104. Sand the cured foam.

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